First, complex systems consist of entities. We can operationalize diverse entities as different actors' types (e.g., public, profit, nonprofit). Data from the domain of global forest governance shows that next to governments, the issue-area is governed by IOs, cities, companies, investors, and nonprofit organizations. A total of 6,239 organizations are active in the global forest governance domain (Pattberg, Kristensen, and Widerberg, 2018). Second, in complex systems, entities interact with each other. For global forest governance, we have checked whether entities are interacting with each other by performing a network analysis of overlapping membership in global governance institutions (a network is then created among institutions within and across issue areas for those that share a member). By projecting the two-mode network of institutions and their members to a one-mode network of institutions, we find that only four institutions out of eighty-four are so called "isolates," meaning that they do not share a single member with another institution. Consequently, institutions in the global forestry governance complex form a tightly knit network in terms of overlapping membership. This in turn suggests that the likelihood of ideas, knowledge, and information spreading across the institutions increases compared to a random network with similar numbers of nodes and edges.

Third, complex governance systems show self-organization. Far from resulting in overlaps and conflicts, governance systems display functional differentiation of tasks and instruments. Data from the global forest governance domain show that next to setting standards and commitments, financing, operating and networking, and information-sharing are also performed as dominant functions (Pattberg, Kristensen and Widerberg, 2018).

Studying governance systems (aggregations of regulations, institutions, rules, norms, and decision-making procedures) as complex systems has a number of important implications. First, instead of focusing on individual institutions, attention is directed toward interactions and interconnections—that is, the physical/social nexus between governance approaches. Second, evaluating global governance systems needs to take into account the complexity of the system—that is, system level performance is not the same as additive performance. And third, because learning, adaptation, self-organization, and feedbacks play important roles in complex systems, we need to critically rethink assumptions about top-down steering and "orchestrating" governance.

The Evolution of Governance Systems: The Case of the Trade Regime

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The international trade regime has undergone a remarkable and unexpected transformation in recent decades. Studying the trade regime helps shed light on how complex systems evolve at the international level. While Article XXIV of the General Agreement on Tariffs and Trade (GATT) authorized preferential trade agreements (PTAs) under certain circumstances, the latter were viewed as rare exceptions to multilateral liberalization. Yet, since the creation of the World Trade Organization (WTO) in 1995, PTAs have proliferated, and over four hundred of these agree-

ments have been signed. In addition, PTAs are now more far reaching. Some recent agreements include provisions on a variety of issues, such as investment, competition policy, intellectual property and the environment. As a result, the international trade regime now overlaps with several other bodies of international law that were previously quite distinct.

In the early 1980s, scholars started considering trade institutions as a regime (Finalyzson and Zacher 1981; Ruggie 1982). The trade regime was recognized as being "complicated," given the nuanced rules, which were difficult to interpret and apply. The early literature typically focused on the exogenous conditions necessary to create and maintain the trade regime, such as the active investment of a benevolent hegemon. However, early studies on the trade regime assumed it was inert and largely overlooked its complex endogenous dynamics.

Theoretical developments in the IR scholarship on regimes (Raustiala and Victor, 2004) were gradually reflected in research on the global governance of trade. Thus, the existence of interactions and overlaps among a growing number of trade institutions began to be acknowledged. Some studies explain the recent proliferation of trade agreements in reference to "contagion" and the effects of competition between countries (e.g., Egger and Larch 2008; Baccini and Dür 2012). Others focus on the legal content of trade agreements, by examining how specific treaty characteristics are diffused across the network of trade agreements (e.g., Horn, Mavroidis, and Sapir 2010; Milewicz et al. 2016). A third stream of literature examines the interactions between bilateral, regional, and multilateral trade agreements (e.g., Davis 2009; Gómez-Mera and Molinari 2014; Gómez-Mera 2015; Brandi 2017). Finally, scholars have studied the consequences of the overlap between trade and nontrade institutions (e.g., Jinnah 2011; Carneiro 2014; Morin and Orsini 2014).

Despite the growing interest in interactions among trade institutions, few studies approach the trade regime as a complex system.[2] Much of the literature on the trade regime remains conspicuously agent-centric and ignores system effects. Even studies that use the concept of "complexity" to analyze the governance of trade focus on how overlap and density constrain and shape the strategies adopted by trade negotiators (Davis 2009; Meunier and Morin 2014). Little attention has been paid to the many unexpected consequences of the interactions and their effects on the evolution of the trade regime itself. While the focus on agency is extremely valuable for understanding the governance of trade, it leaves some important— more holistic—questions unanswered.

Is the trade regime a complex system? The introduction to this forum argues that a complex system displays four characteristics: it includes multiple units of various types, these units are intricately interconnected, they operate at different levels, and they constitute a system that is open to its external environment. The trade regime has all four characteristics.

First, the trade regime is made up of elements of various types. It includes WTO multilateral agreements and hundreds of PTAs (Dür, Baccini, and Elsig 2014). The scope of these agreements varies in terms of the depth of economic integration. They can be partial, for example, when arrangements are limited to a specific industrial sector, or comprehensive, which is the case for common markets that share a single currency and common regulatory bodies. PTAs also vary in terms of their level of institutionalization. Some rely on intergovernmental arrangements, while others delegate competencies to supranational agents. A multitude of government officials, businesses, and civil society actors interact through and around these institutions.

Second, these elements are deeply interconnected and interdependent. Trade institutions are held together by a shared set of liberal principles and objectives, which were first laid out in the GATT of 1947. When compared, trade agreements

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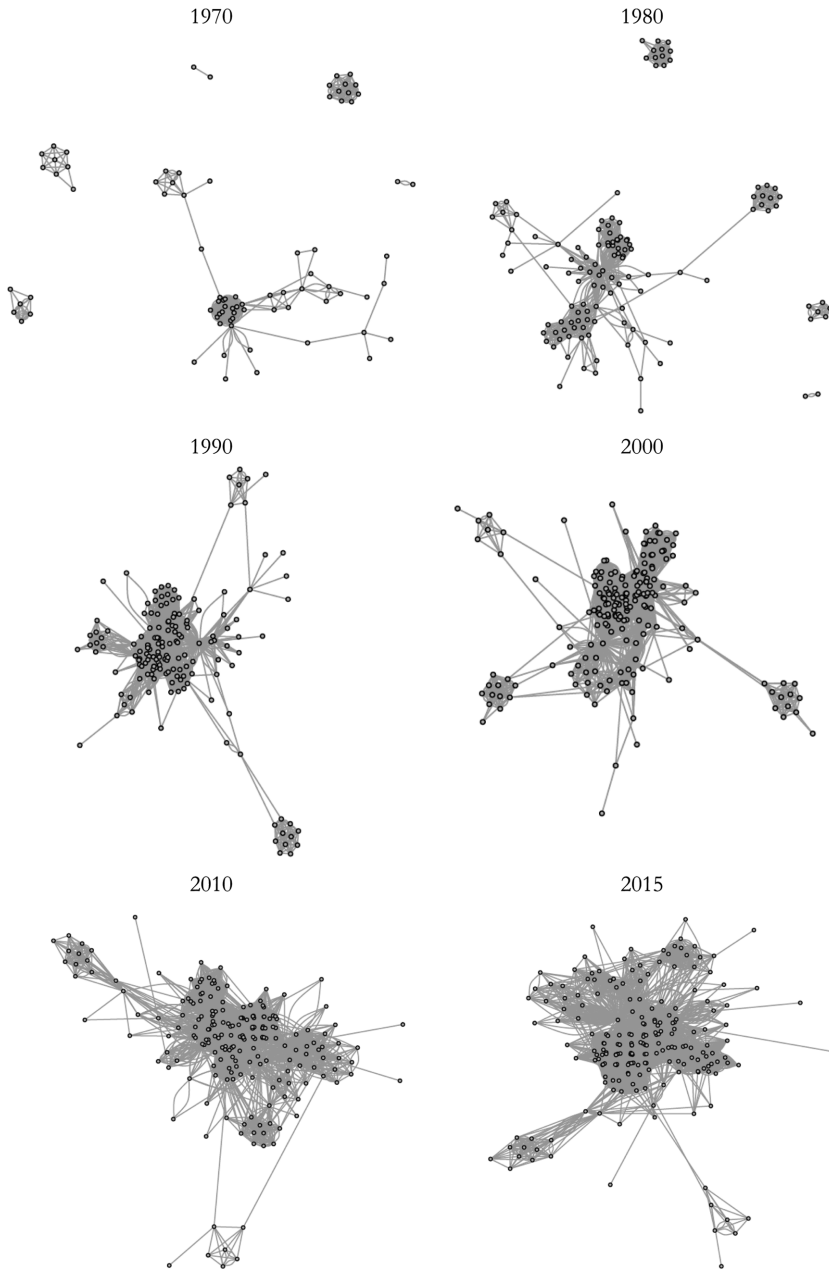[2] One exception is Morin, Pauwelyn, and Hollway (2017).

Figure 1. Evolution of the PTA Network Structure.
Source: Authors, with data from Dür, Baccini, and Elsig 2014

present a degree of coherence, despite significant differences in their design and their impressive proliferation. This is largely the result of dense social and political links among the elements in the system (Wolfe 2005; Pauwelyn and Alschner 2014). For example, Solis, Stallings, and Katada (2009) argue that policy emulation among like-minded elites contributed to the spread of trade agreements in the Pacific Rim. These trade agreements are linked and have formed a network structure. Figure 1 shows the evolution of the PTA network. Each node represents a country and

each connection represents a PTA between countries. Research has revealed that this evolving network structure influences the ways in which countries interpret existing agreements and negotiate new ones. According to Lee and Bai (2013), "transitivity" and "homophily" dynamics in the network of trade agreements explain why countries tend to join PTAs.

Third, the structure of the trade regime has multiple levels. The actors and institutions in the trade regime occupy a series of interrelated levels—multilateral, regional, and bilateral. In addition to this geographical structure, a legal structure differentiates among macro principles, meso norms, and micro rules. The dynamics at one level, such as proliferation, competition, diffusion, innovation, or concentration, affect the dynamics at different levels of organization (Kim and Manger 2017). This applies to both the geographic and legal scale. For example, competition between two regional blocs might favor the proliferation of bilateral agreements concluded by the two blocs with third countries. Likewise, the competition between alternative norms, setting out how science should inform trade policy, can lead to the proliferation of detailed rules governing sanitary restrictions on food products.

Finally, the trade regime is open to its environment and interacts intensively with other systems. One prominent example is the gradual imbrication of the trade and investment regimes. As Puig (2014, 493) states, "What had been relatively clear distinct regimes are now blurring, forming an emerging international economic law 'regime complex.'" With the convergence of the trade and investment regimes, the public and private enforcement of international economic law has become increasingly entangled. Recent trade agreements contain "hybrids" of public and private enforcement, allowing multiple actors to "interact within complex ecologies of adjudication." (Puig 2014, 493) In this sense, the trade governance system (including PTAs linked by partly overlapping membership) coevolves with the broader global economic system (including firms linked by various types of transaction and ownership). Positive feedback between the system of governing institutions and the system of governed actors increases returns and stimulates their respective growth.

The trade regime also displays the three properties of complex systems identified in the introduction, namely self-organization, emergence, and adaptation. The trade regime is a self-organizing system. The wide range of actors and institutions involved in trade governance interact without any central hierarchical coordination. While the WTO plays a certain orchestrating role, it remains a "member-driven" organization. The rules governing trade relations emerge from negotiations between governments, often with input from private and technical actors. The governments do not even notify the WTO systematically of their PTAs, despite the requirements of the GATT Article XXIV (Mavroidis 2011).

The second property of complex systems, emergence, refers to the unexpected systemic outcomes resulting from the interactions between the units in the system. The trade regime has directly contributed to the emergence of economic globalization, a feature that is not only greater but also different than the sum of the parts of the trade regime. The depth of integration and interdependence achieved over the past seventy years would have been hard to envisage in 1947, when the GATT was concluded. Yet, by reducing national trade barriers, the GATT and the first PTAs have had an important impact on the nature of international production, as well as investment patterns (Orefice and Rocha 2014). They have led to the contemporary increase in the trade in services, the growth in investment flows, the development of intra-industry and intrafirm trade, the creation of complex chains of suppliers, and the expansion of transnational firms. These radical transformations are so profound that new measurements and concepts are required to make sense of the emerging trade realities. For example, most experts now consider that the notion of "trade surplus" is an obsolete measure of national economic performance, whereas the concept of "global value chains" now reflects the need to modernize the trade regime (Baldwin 2014).

These shifting patterns in international trade have led to adaptive reactions in the trade regime, the third property of complex systems. The early multilateral and regional trade agreements primarily focused on the exchange of market access and facilitating the exchange of end products. These agreements generated a significant expansion in trade. In turn, this has created new incentives and additional regulatory pressures—a feedback loop—with implications for the coordination and harmonization of various behind-the-border rules. In response to this, recent PTAs provide a much deeper level of integration, with detailed chapters on service liberalization, regulatory cooperation, labor mobility, telecommunications, competition policy, financial regulations, intellectual property, investment protection and public procurement. It is clear that the number and scope of recent PTAs go far beyond what was anticipated when Article XXIV was drafted in 1947 (Chase 2006).

These properties—self-organization, emergence, and adaptation—create endogenous dynamics. One key insight of complexity theory is that complex systems evolve at the edge of order and chaos. As mentioned in the introduction to this forum, reinforcing positive feedback makes complex systems particularly sensitive to their initial conditions. Joost Pauwelyn provides examples of such path dependency in the trade regime. He states that the initial articulation of "national treatment" and the old notion of "fair and equitable treatment of foreign investors" have become the dominant standard in international economic law. He goes on to explain that network externalities favor these standards over newly introduced clauses, even when alternative clauses are clearly more suitable (2014, 414). However, complex systems also have negative feedback loops. Unexpected trade disputes, disguised trade restrictions and social contestation have all contributed to the introduction of additional safeguards in trade agreements, notably with regard to investment liberalization and environmental protection (Morin and Gagné 2007; Morin, Pauwelyn, and Hollway 2017). This combination of positive and negative feedback makes complex systems unstable and makes it impossible to predict exactly how they will evolve.

When it comes to analyzing the trade regime, the only reasonable prediction that complexity theory can provide is that endogenous negative and positive feedback will continue to make the trade regime increasingly more complex. Complexity theorist Stuart Kauffman believes that complex systems have the propensity to grow endogenously in their complexity. He suggests that this feature could be a candidate fourth law of thermodynamics (2000, 142). Although Kauffman is referring to the biosphere, other complexity theorists have shown that governance systems display similar autopoiesis: nonlinear interactions between existing elements generate new elements, making the system more complex (Teubner 1993; Luhmann 1995).

In this perspective, complexity is a continuous not a dichotomous variable. Complexity is often considered to be either present or absent in a system. However, it can be conceived as a continuum and measured along various dimensions corresponding to the characteristics of complex systems: the number and diversity of units, the density of their interconnections, the multiplicity of scales, and the degree of interactions with the external environment. Presumably, a certain threshold is necessary on each of these dimensions for a system to be sufficiently complex to exhibit the properties associated with complex systems—namely, self-organization, emergence, and adaptation. However, even when the threshold is reached, complex systems tend to continue to grow in complexity.

This is the case for the trade regime. It reached a threshold in the early 1990s and has been exhibiting complexity properties since then. It was around that time that trade institutions started to proliferate exponentially. They are also becoming increasingly diverse, with the emergence of new institutional forms, such as plurilateral sectoral agreements (e.g., the Anti-Counterfeiting Trade Agreement), routinized trade summits (e.g., the India-Brazil-South Africa Summits), venues for

regulatory agencies (e.g., the International Competition Network) and collaboration between intergovernmental organizations (e.g., the Standards and Trade Development Facility). The trade regime has expanded geographically. A growing number of countries are involved, through multilateral, intra- and extraregional agreements, which have intensified the interconnections between trade institutions. Finally, the trade regime continues to interact with other international regimes. And as mentioned above, recent PTAs commonly include full-fledged chapters on nontrade issues, such as environmental protection, labor standards, and human rights (e.g., Horn, Mavroidis, and Sapir 2010; Bruhn 2014; Milewicz et al. 2016).

The claim that complex systems grow in complexity is not a deterministic prediction but a probabilistic one. Rich ecosystems have turned into deserts and vibrant cities have shrunk. Likewise, previous trade systems have collapsed, and the current trade system is not immune to this risk. Yet, it is reasonable to expect that: the number of PTAs in force will increase, new institutional forms will emerge to regulate supply chains, the WTO will continue to expand its membership, and the average trade agreement will come to cover additional issue-areas, such as taxation or data security.

The increasing complexity of complex systems and, more generally, their constant evolution, encourage trade analysts to take the temporal dimension more seriously when it comes to studying trade institutions. While history is a dimension that is absent from several disciplines, ranging from Newtonian mechanics to classical economics, it cannot be ignored in complex system analysis. Negotiating a trade agreement in 2019 is difficult to compare with negotiating GATT in 1947. Therefore, causal explanations and mechanisms may not be applicable in different contexts. While it is illuminating to study and identify patterns in social and international dynamics, it is important to acknowledge contextual effects. Complexity theory warns trade analysts against the relentless search for universal and timeless causal explanations.

Another useful lesson for trade analysts is that the resilience of the trade regime does not depend solely on the WTO. The trade regime is populated by hundreds of institutions, which means that the fate of one institution does not determine the evolution of the entire system. In fact, complexity theory suggests that units that are not central can have disproportionate and unexpected effects through nonlinear systemic change. Arguably, the 1957 Treaty of Rome and the 1992 North American Free Trade Agreement had this kind of butterfly effect on the entire trade regime. Instead of being overly concerned with the WTO stalemate, trade policy analysts should examine whether the appropriate feedback mechanisms are in place to ensure that trade negotiators can learn continually from institutional experiments in various parts of the world, at bilateral and regime levels.

In sum, complexity approaches provide a series of illuminating insights into the evolutionary dynamics of the global governance of trade, complementing traditional agent-centric IR approaches. The latter focus on actors' incentives and capabilities and, thus, cannot fully account for the features and patterns of evolution observed in trade institutions. Most of the trade regime's expansion was driven by state actors' deliberate decisions. However, their choices have had significant unintended consequences, which have led to unexpected outcomes. By considering the trade regime as an open, living system, composed of interdependent and interacting elements and self-adjusting actors, complexity approaches can make useful contributions. They reveal systemic reverberations, emergent properties, and unexpected effects, thus, shedding new light on some aspects of the recent evolution in the trade regime.